

A Pulsar's Giant Surprise: uGMRT Discovers Extreme Radio Flashes from a Rare Neutron Star

Using the upgraded Giant Metrewave Radio Telescope (uGMRT), an international team of astronomers from India, the US, Germany, and the UK discovered extraordinarily bright, microsecond-duration radio flashes from a rare type of neutron star. The GMRT (Giant Metrewave Radio Telescope) is a world-class, low-frequency radio telescope run by the National Centre for Radio Astrophysics (NCRA), a unit of the Tata Institute of Fundamental Research (TIFR), an aided institute under the Department of Atomic Energy (DAE). Today, it remains one of the world's most sensitive radio telescopes, playing a pivotal role in key discoveries.

Neutron stars are extremely dense, leftover cores of giant stars that have exploded. A pulsar is a rapidly spinning, highly magnetized neutron star that emits radio waves from regions around both of its magnetic poles. Just as a lighthouse beam sweeps by at regular intervals, the pulsar's radio light is detected periodically, revealing its intrinsic rotation rate. Lead author Saptarshi Sarkar and the team observed PSR J1227-4853. It is a transitional millisecond pulsar, a kind that switches between two states - feeding on a companion star and flashing as a rapidly spinning radio pulsar. Catching a pulsar in this transitional act gives astronomers a rare chance to study how neutron stars evolve, and that is exactly what this observation offered.

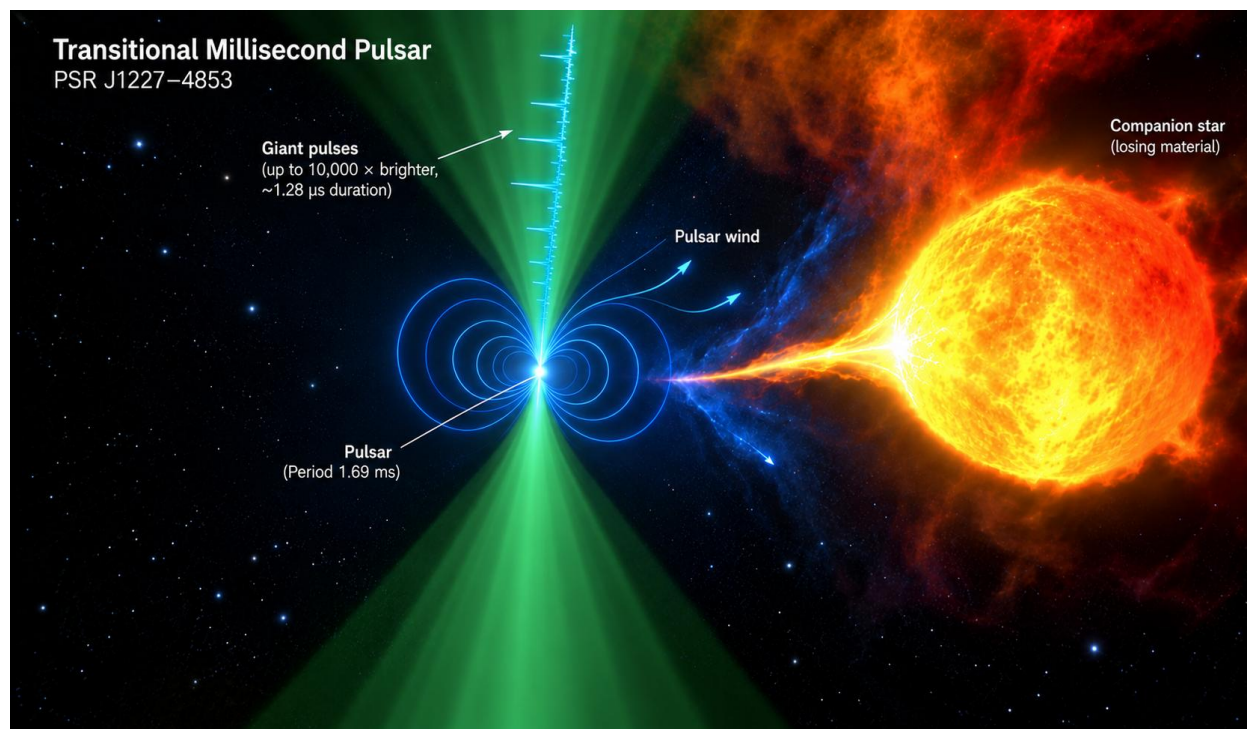
PSR J1227-4853 spins an astonishing 592 times a second (that's almost twice as fast as a regular kitchen blender!). The team patiently monitored the pulsar for about 174 hours over several years. From this enormous amount of data, 235 individual giant radio pulses were found.

"What struck me most was just how extreme these pulses are, both in terms of their brightness and their short duration. Some flashes were nearly 1,000 times brighter than the pulsar's normal emission, while the shortest lasted just 1.28 microseconds, about 100,000 times shorter than an eye blink! It is remarkable to see such intense and brief bursts of radio emission from a neutron star," said Saptarshi Sarkar, lead author of the study and a PhD student at NCRA-TIFR.

Furthermore, these giant pulses were observed from only one of the pulsar's two magnetic poles. This suggests the flashes are not produced equally at both poles, which hints at their spatial origin around the pulsar. Additionally, there are episodes of intense clustering separated by relatively quiet periods. For instance, on 6th December, 2020, the uGMRT caught about 114 giant pulses in a single hour, revealing an intense burst of activity from the pulsar. This pattern of bursts resembles the "burst storm" seen from FRB 20200120E, a repeating Fast Radio Burst (FRB). FRBs are another class of extremely bright, brief radio flashes, mostly known to originate from outside our galaxy. Most are one-off bursts, while some are known to repeat. Although the resemblance does not mean the two astrophysical phenomena have the same origin, it raises the intriguing possibility that these disparate cosmic radio flashes may have some commonality in the underlying physics.

Jayanta Roy, a co-author and an Associate Professor at the National Centre for Radio Astrophysics (NCRA), attributed the discovery to the uGMRT's high sensitivity, microsecond time resolution, and its ability to run long-term monitoring campaigns.

Published in The Astrophysical Journal, the study establishes PSR J1227–4853 as a new laboratory for exploring how rapidly rotating neutron stars generate some of the brightest and shortest radio flashes known, and may help astronomers understand the diverse mechanisms behind the universe's most extreme radio bursts.



A Cosmic Shape-Shifter Fires Giant Radio Pulses: Artist's impression of PSR J1227–4853, a cosmic "shape-shifter" pulsar. Using the uGMRT, astronomers have discovered giant radio pulses from such a system for the first time. Some pulses were nearly 10,000 times brighter than normal, while the shortest lasted just 1.28 microseconds.

Original image Credit: NASA's Goddard Space Flight Center

Publication: "Detection of Giant Pulses from the Transitional Millisecond Pulsar J1227-4853", Saptarshi Sarkar, Jayanta Roy, Bhaswati Bhattacharyya, Paul S. Ray, Sanjay Kudale, Paulo C. C. Freire, Patrick Weltevrede, and Matthew Kerr, 2026, The Astrophysical Journal, Volume 1007, Number 1. DOI: 10.3847/1538-4357/ae8798

Contact:

Saptarshi Sarkar:	email: sarkar@ncra.tifr.res.in ;	mobile: +91 8777582430
Jayanta Roy:	email: jroy@ncra.tifr.res.in ;	mobile: +91 9423577604
Bhaswati Bhattacharyya:	email: bhaswati@ncra.tifr.res.in ;	mobile: +91 7262843643
Sanjay Kudale:	email: ksanjay@gmrt.ncra.tifr.res.in ;	mobile: +91 9552658776